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PART 2 AND COMPARABLE STATE LAW**

**WEDGEWIRE SCREENS: ADDITIONAL DESIGN FOR
[REDACTED] CONFIGURATION AT
SCHILLER STATION
PORTSMOUTH, NEW HAMPSHIRE**



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1.0 Introduction and Background

Schiller Station is located in Portsmouth, New Hampshire on the southwestern bank of the Piscataqua River, which forms the boundary between coastal New Hampshire and Maine. Schiller Station has three generating units (Units 4, 5 & 6) which withdraw once-through cooling water from the Piscataqua River via two separate cooling water intake structures (CWISs) located on the Piscataqua River. In April 2018, the EPA issued a National Pollutant Discharge Elimination System (NPDES) permit for Schiller Station which stated “To minimize entrainment, the permittee shall install and operate a fine mesh wedgewire screen intake system for the cooling water intake structures of Units 4, 5, and 6, with a pressurized system to clear debris from the screens” [Ref. 7.20]. This system has been determined to be the best technology available (BTA) for minimizing impingement and entrainment impacts at Schiller Station. A site-specific study was undertaken to test screen blockage and perform biological sampling in order to collect entrainment data. Due to cost, engineering, and schedules restrictions, it was not practical to use a full-size screen for the site-specific study. Therefore, smaller and more readily available wedgewire screens were used. The test screens matched key parameters of the intended full-scale screens which included: screen slot width, through-slot velocity, flow dynamics around the screen, and screen elevation within the water column. However, after testing of the study wedgewire screens, the test results determined the function/operation could not be maintained for a desirable period of time. The complete results of the pilot study are set out in the following two reports that were submitted to Region 1 of the U.S. Environmental Protection Agency (EPA) in July 2020:

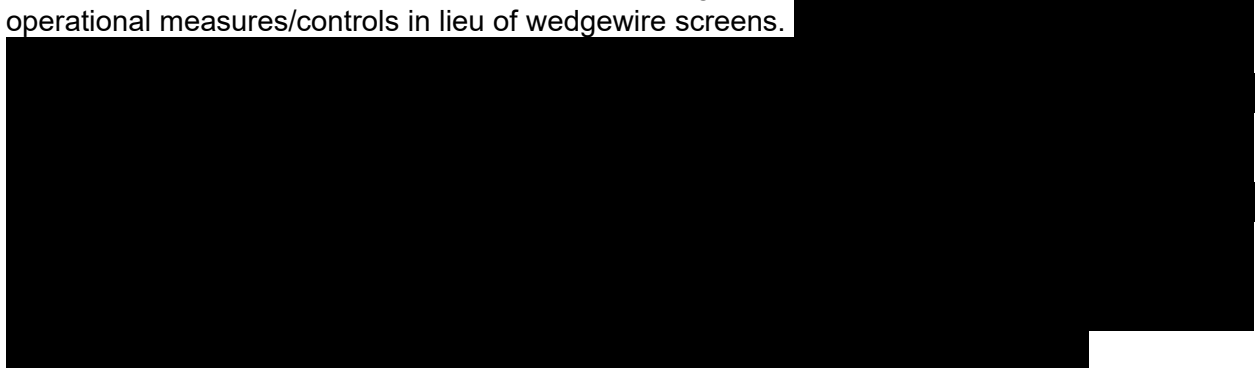
- Wedgewire Screen Site-Specific Study Engineering Evaluation, GSP Schiller LLC - Schiller Station, Portsmouth, New Hampshire; Enercon Services, Inc. (July 28, 2020)
- Evaluation of the Entrainment Reduction Performance of 0.8-mm and 3.0-mm Cylindrical Wedgewire Screens at Schiller Station; Normandeau Associates, Inc. (July 2020)

Based on the results of this pilot study, it was concluded that installation of wedgewire screens as contemplated in the 2018 NPDES permit would be imprudent and that alternative options for 316(b) compliance at the facility needed to be evaluated.



On March 31, 2021, GSP Schiller filed a permit modification with EPA requesting changes to the Clean Water Act (CWA) 316(b) provisions in the National Pollutant Discharge Elimination System (NPDES) permit for Schiller Station, including the wedgewire screen provisions discussed above, in light of the pilot study results and the operational profile of the facility. GSP Schiller proposed specific operational measures/controls, including flow reductions, as an alternative for 316(b) compliance.

The purpose of this report is to provide a configuration detailing wedgewire screen installation considerations at Schiller Station in light of the results of the 2019 pilot study. This report provides EPA a point of comparison with GSP Schiller's pending permit modification request to incorporate operational measures/controls in lieu of wedgewire screens.



This report is intended as a point of comparison for the agency in its assessment of BTA and evaluation of the modification request in light of the results of the 2019 pilot study carried out at Schiller Station.

2.0 Configuration Inputs

2.1 Location

Schiller Station is located in Portsmouth, New Hampshire on the southwestern bank of the Piscataqua River. Unit 4 draws water from an intake tunnel approximately [REDACTED] from the north bulkhead (Screen House #1). The CWIS for Units 5 and 6 are located within the south bulkhead (Screen House #2).

[REDACTED]

[REDACTED] This location was previously determined to be an acceptable accommodation which provided high sweeping flow velocities to promote the hydraulic bypass effect while being as near-shore as practical. [REDACTED]

[REDACTED]

2.2 Operational Constraints

[REDACTED]

Orientation: Screens will be oriented so that the longitudinal axis of the screen is parallel to the predominant direction of the river current, as informed by acoustic doppler current profiler (ADCP) data.

[REDACTED]

Screen Slot Width: 0.8mm (permit requirement)

Intake Flow Rate: The screens shall be capable of providing the continuous, concurrent design intake flow (DIF) of Unit 4, Unit 5, and Unit 6.

An extended site-specific pilot test of the cylindrical wedgewire (CWW) screen technology in the Piscataqua River in the vicinity of Schiller Station was performed from late 2018 to late 2019 in conformance with Part I.A.11.a.1 of NPDES Permit No. NH0001473 [Ref. 7.20]. During the pilot test, the screens accumulated substantial amounts of fouling and developed significant damage. Based upon differential pressure calculations, it was estimated a minimum of 45% of water withdrawn through the 0.8mm test screen assembly bypassed the fine-mesh openings. [REDACTED]

[REDACTED]

[REDACTED]

The screens could still develop high levels of fouling and critical damage [REDACTED] [REDACTED] leading to partial or total loss of screening effectiveness. Debris loading at the existing traveling water screens could provide an indication for a malfunctioning screen; however, this indication could be at a delay from the inception of the degraded condition.

[REDACTED]

2.4 Geotechnical Data

[REDACTED]

3.0 Operating Experience

This section provides a summary of the observations, lessons-learned and operating experience gained from previous CWW screen designs. This information has been and will continue to be utilized to improve the design and functionality of this new screen [REDACTED] configuration.

3.1 Summary of Previous Designs

3.1.1 Merrimack River Project

The Merrimack River project utilized a 3 mm slot-width, 12-inch diameter wedgewire screen anchored on the river floor to model 96-inch half-screens. Acoustic doppler current profiler (ADCP) surveys were conducted to obtain river velocity data in the vicinity of the intake throughout the duration of testing. Biological samples taken from the flow through the wedgewire screen were compared to control samples taken from the flow through the existing intake structure to determine the effectiveness of the wedgewire screens. More information regarding the reduction in entrainment experienced at the Merrimack River can be found in the evaluation report (Ref. 7.16).

3.1.2 Schiller Station Site Specific Study

Prior to installation of the screens outlined in this report, a site-specific study was undertaken to test screen blockage and perform biological sampling to collect entrainment data. Due to cost, engineering, and schedules restrictions, it was not practical to use a full-size screen for the site-specific study. Therefore, smaller and more readily available wedgewire screens were used. The test screens matched the key parameters of the intended full-scale screens including screen slot width, through-slot velocity, flow dynamics around the screen and the screen elevation within the water column.

3.2 Lessons Learned

3.2.1 Merrimack River Project

This section provides a summary of the observations and lessons-learned from the 2017 CWW screen pilot test at Merrimack Station. A summary of the items that have been and, if necessary, will continue to help inform either a full-scale wedgewire screen configuration or future testing at other GSP sites is provided below.

- In general, the riverbed was observed to consist of loose sand, with large sand dunes (up to 2' tall) periodically on the river bottom and observed to move throughout the river during periods of high flow. This resulted in significant sand entrainment in the testing samples during the first few weeks of testing. Measures may need to be taken in a full-scale design to limit the amount of sand entrained in the circulating water flow.
- The river flows observed during the first few weeks of testing were abnormally high, likely due to heavy rain events. As a result of this lesson learned, ADCP data will be used to confirm the preliminary river velocity estimation, and margin will be added to the peak value in all analyses.
- No significant biofouling was observed on the test screen, confirming that the [REDACTED] material would help limit biofouling on a full-scale design. In one instance, the test screen

was blocked by a piece of large-surface-area debris, which was removed by backflushing the testing pumps. This operating experience suggests the use of an air burst system (ABS), which functions similarly to the executed backflush, on the full-scale design would effectively remove debris from the screens.

- It is also recommended that the design for any future testing include hard suction hose (to prevent kinks that reduce flow) and ensure that the instrumentation is oriented so that it can be easily seen by the operators when fine-tuning the flow.

3.2.2 Schiller Station Site Specific Study

After performing the Schiller Station site specific study, it was found that several critical parameters did not meet requirements for sustainable operation at Schiller Station. A significant amount of fouling and damage to the pilot wedgewire screens were observed during the test period of continuous operation. The test screens were initially installed in December of 2018 and were retrieved in January of 2020. In the duration which the screens were submerged, the combined effects of the accumulated fouling and screen damage resulted in a loss of entrainment exclusion effectiveness.

The fouling was comprised of high-density siltation and biogrowth which accumulated along the axial support bars which expanded to the remainder of the screen surface. The fouling observed on the pilot wedgewire screens was assumed to be due to mechanical compaction of the fouling deposits against the axial support bars and between the circumferential wire rings. Though the construction material used in the construction of the pilot wedgewire screens is anticorrosive and biogrowth resistant, the compacted fouling deposits were believed to have provided a host surface on which biogrowth occurred. It was noted that, while biogrowth occurred where fouling deposits collected, there was a negligible amount of fouling on the risers, flow diverters, and conical end closures. The largest amount of fouling observed during the site-specific fouling test encompassed 36% of the 0.8mm test wedgewire screen assembly. Underwater imagery of the observed fouling is provided in Figure 2.

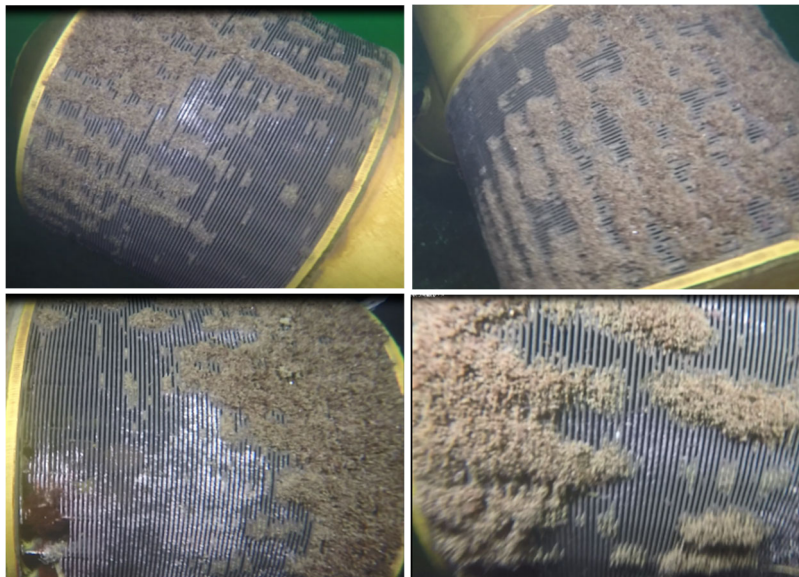


Figure 2. Underwater imagery of observed biofouling.

During the duration of the site-specific pilot test, an increasing severity of damaged surface area was observed. The damage was initially localized on the riverbed facing sides of the assemblies and rapidly expanded to a large opening in the wire screens. At the conclusion of the study period, an estimated 19.25% of the surface area of the 0.8mm test wedgewire screen assembly was exposed. The damaged areas of the 0.8mm test wedgewire screen assembly measured as wide as 3.5 inches. This would allow for fish, shellfish, and debris larger than the 0.8mm slot width to be withdrawn through the cylindrical wedgewire screen. Due to the hydraulic effects associated with the screen damage, it is estimated that 44.5% of the water withdrawn by the test wedgewire screen assembly would bypass the narrow slots under clean screen conditions. The amount of bypassing flow would be compounded by the amount of undamaged surface area clogged by fouling. The bypass of the screens due to damage and the removal of screens for maintenance would result in a reduction in entrainment exclusion effectiveness. Imagery of the damaged portions of the test wedgewire screen assembly is provided in Figure 3.



Figure 3. Imagery of damaged portions of the test wedgewire screen assembly.

Over half of the 0.8mm wedgewire screen assembly surface area was affected by either fouling or damage. To ensure observed fouling and damage do not impact the normal operations of Schiller Station, a full-scale installation of cylindrical wedgewire screens must be deployed in a way

3.3 [REDACTED]

3.3.1 [REDACTED]

[REDACTED]

3.3.2 [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

4.0 Configuration Summary

4.1 Johnson Screen Model Selection

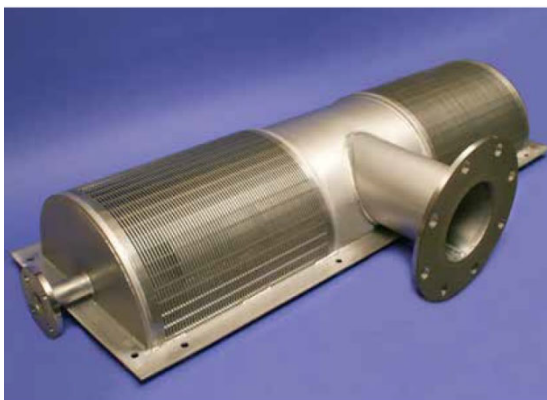
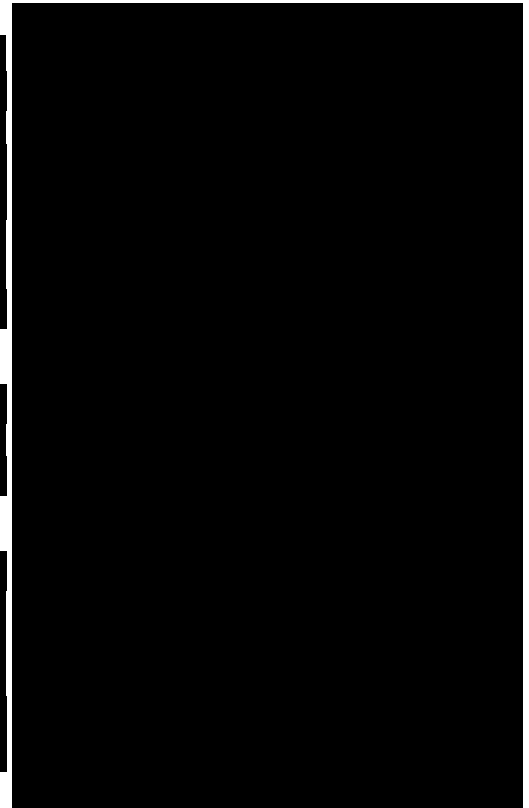
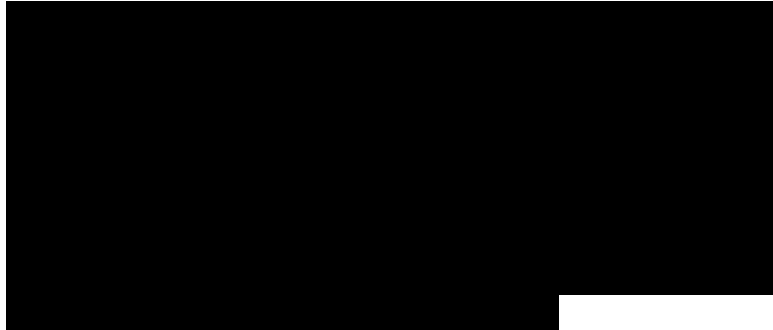


Figure 6. Johnson passive intake half-screen (left) and T-screen (right).

The functional requirements of two 96" half screens can be achieved with 6 full 72" cylindrical T-shaped screen. Therefore, to provide for frequent inspections and continuous operation, this configuration utilizes 72" cylindrical T-screens.

The cylindrical wedgewire screens would process the combined DIF of Unit 4, Unit 5, and Unit 6. When Unit 4, Unit 5, and Unit 6 are concurrently operating at full load, the screens would handle a total flow of 87,290 gpm (125.8 MGD). The cylindrical wedgewire screens would also maintain the maximum through screen velocity of 0.5 ft/s, as prescribed by Part I.A.11.a.1 of NPDES Permit No. NH0001473. Johnson Screen provided a design option for 0.8mm cylindrical wedgewire screens which is based on the operational constraints listed in Section 2.2. The parameters of the cylindrical wedgewire screen preliminary design are provided in Figure 7.

Parameter	Value
Model	Johnson Screens T-72HC
Quantity	6
Slot Width	0.8mm
Screen Diameter	6' – 0"
Overall Length	21' – 1"
Maximum Through Screen Velocity	0.462 ft/s
Centerline to Flange Length	5' – 9"
Minimum Operating Depth	12' – 0"
Outlet Connection	48" AWWA Class D Flange
Hydroburst Connection	10" AWWA Class D Flange
Approximate Dry Weight	8,400 Lbs per Screen

Figure 7. Parameters of cylindrical wedgewire screen proposed configuration

At the most recently calculated actual intake flow [REDACTED], the through screen velocity with six fully clean screens would be 0.264 ft/s. The estimated through screen velocity provided by Johnson Screens was calculated under clean screen conditions. If, as observed during the site-specific pilot study, significant biofouling was to occur and portions of the screen area became blocked by debris, the total screen open area could be reduced. This area reduction would lead to increased actual through screen velocities. Estimated through screen velocities at corresponding intake flow rates and screen cleanliness are shown in Figure 8. When Unit 4, Unit 5, and Unit 6 are not concurrently operating, the extraneous cylindrical wedgewire screens could be stored above the surface of the water to reduce biofouling and potential damage. Estimated through screen velocities at design intake flow (DIF) with corresponding quantities of operating screens and screen cleanliness are shown in Figure 9.

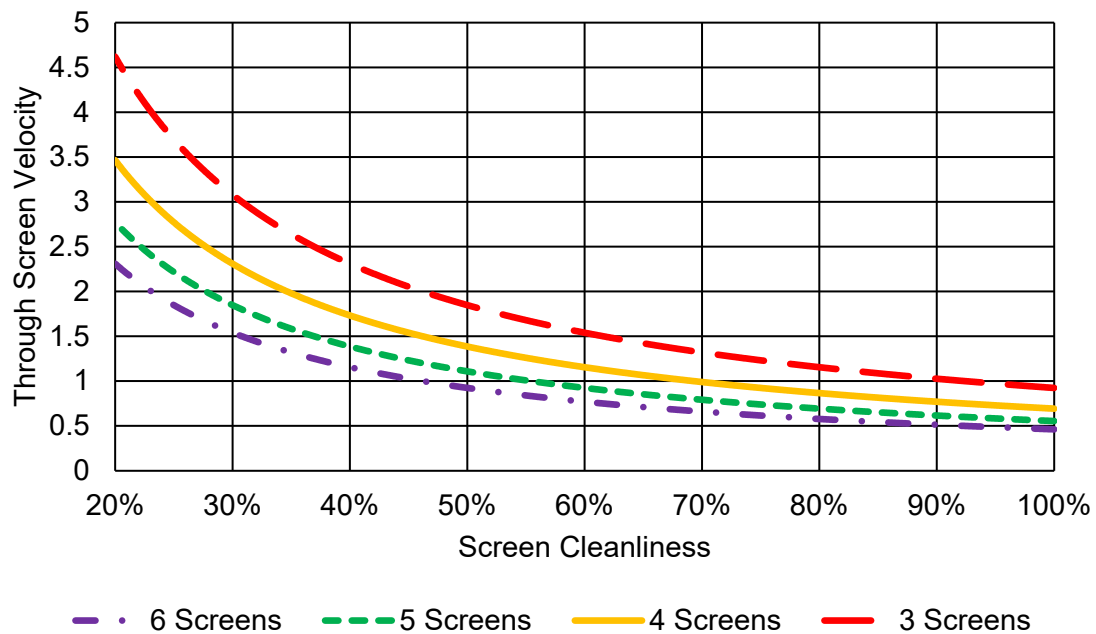


Figure 8. Plot of estimated through screen velocities at 3-year AIF with corresponding quantities of operating screens and cleanliness

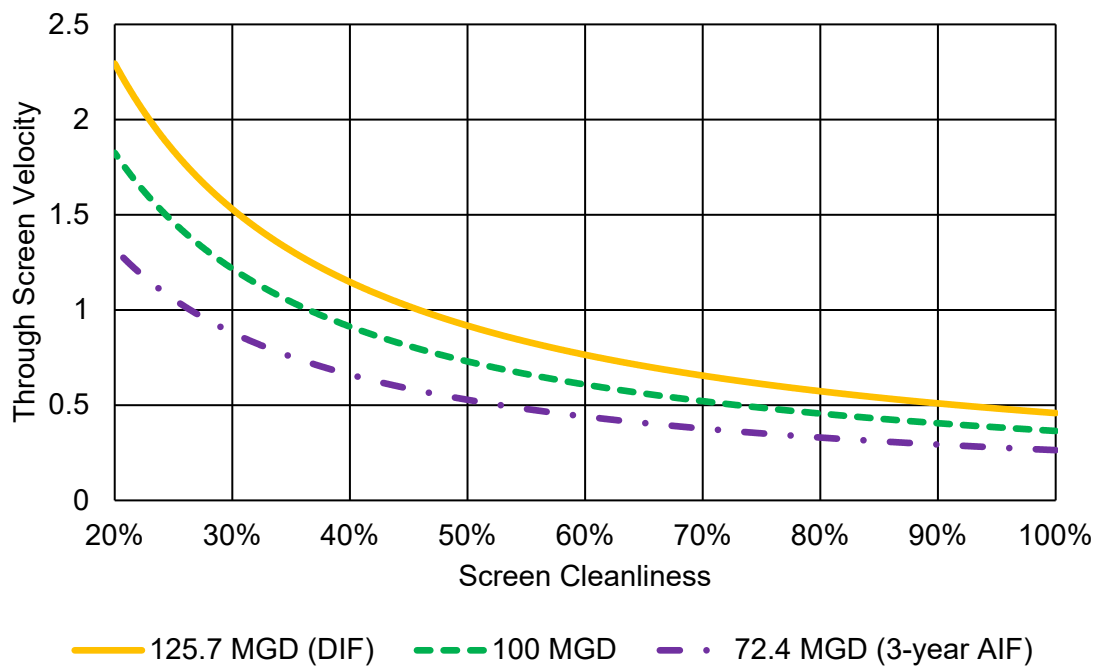


Figure 9. Plot of estimated through screen velocities at DIF with corresponding intake flow rates and screen cleanliness.

4.2 [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

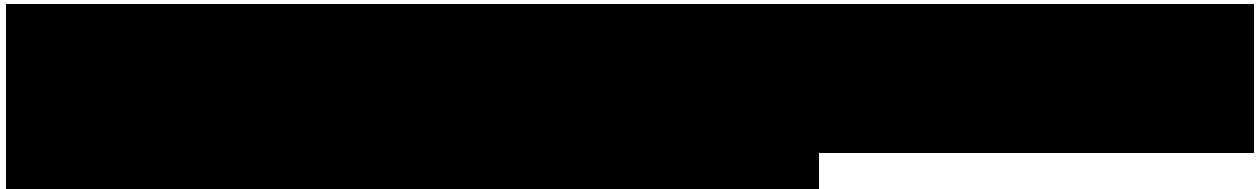
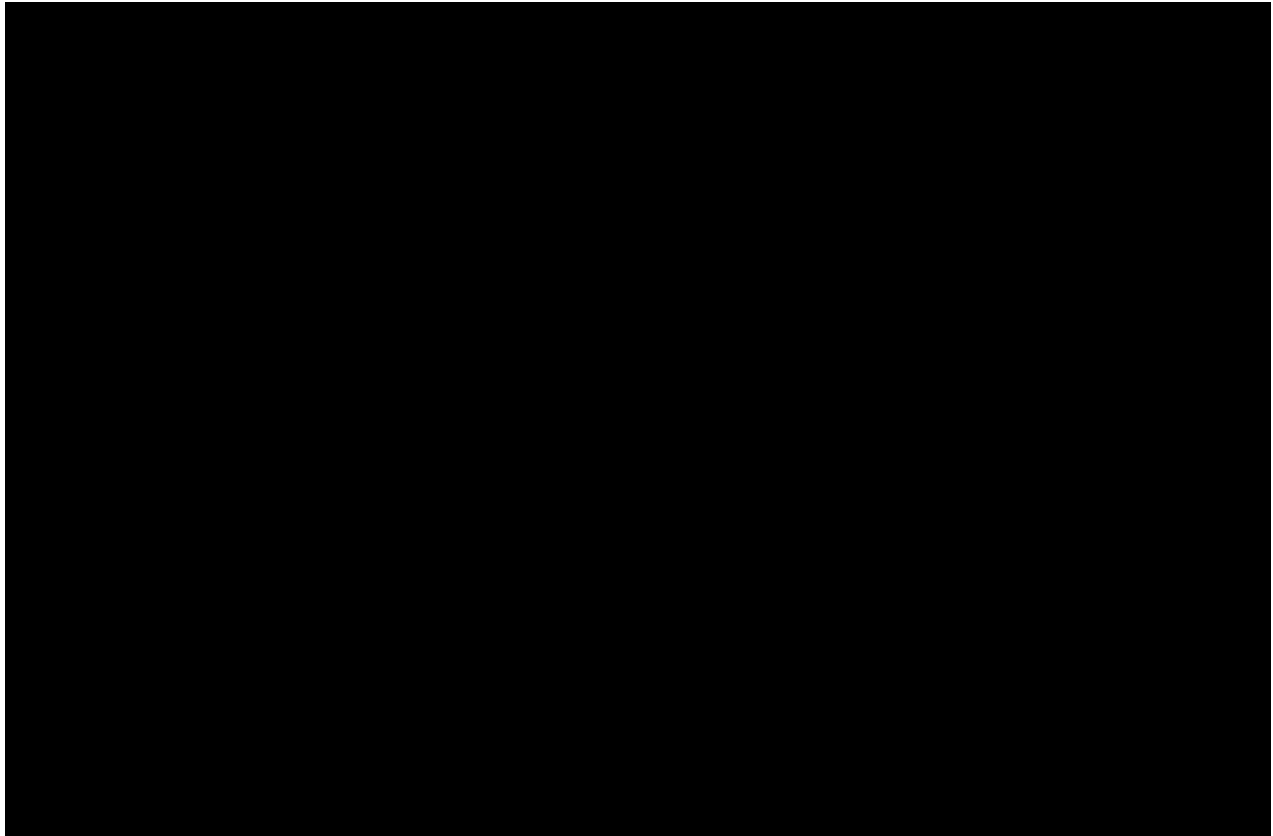
[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



4.3 Intake Line Junction Box

The discharge lines from each cylindrical wedgewire screen are intended to meet at a concrete junction box [REDACTED]. At the junction box, the flow from each cylindrical wedgewire screen would mix and equalize before distribution to the existing intake structures. Utilizing a junction box would provide a location for flow distribution to the two intake structures and would allow for operational flexibility. The individual screens would be disconnected from the junction box [REDACTED] for performance of online maintenance, repairs, and replacements. The junction box connections would be sealed shut [REDACTED]. When one or more cylindrical wedgewire screens is disconnected from the junction box, the flow would be drawn through the remaining screens at an increased average through screen velocity. Alternatively, in the event of a large scale fouling or damage event, a panel on the roof of the junction box would

be hinged to allow for bypass of the cylindrical wedgewire screen assembly. [REDACTED]

[REDACTED] This operation would not be anticipated to be a regular event; however, inclusion of a bypass flow path would be necessary for continued operation of the station during fouling or damage events.

4.4 Intake Pipe Routing and Attachment

[REDACTED] Flow would be delivered to Intake Structure #1 and Intake Structure #2 through separate intake lines. Each intake line would originate at a common intake line junction box [REDACTED]

[REDACTED], will be determined at a later date. This calculation would determine [REDACTED]

[REDACTED]. During the site-specific pilot study, the intake hose utilized was intended [REDACTED]

Intake Structure #1 would draw flow through a new 46 inch nominal diameter fiber reinforced plastic (FRP) pipe. The new intake line would be connected directly to the existing intake pipe which provides flow from the offshore intake to Intake Structure #1. The flow would be withdrawn through the existing intake barrier bar rack upstream of the Unit 4 traveling water screen and pump bays. Intake Structure #2 would draw flow through a new 54 inch nominal diameter FRP pipe. The new intake line would be connected directly to the new Intake Structure #2 through a new penetration. The flow would be withdrawn through the existing intake barrier bar racks upstream of the Unit 5 and Unit 6 traveling water screens and pump bays.

5.0 Key Construction Activities

The general configuration, assumptions, and other considerations of the new configuration described in this report are given in sections 2.0, 3.0, and 4.0. The sections below describe key construction activities for the depicted and described configurations presented in this report.

5.1 [REDACTED]

5.1.1 [REDACTED]

During the site-specific study it was intended to utilize earth penetrator screws to anchor [REDACTED]. However, upon construction, the divers found the riverbed to be comprised of rock not able to be screwed in to manually.

5.1.2 Barges

Barges will be required for [REDACTED] as well as the regular maintenance and replacement of screens.

- Geotechnical borings: Barges will be required to obtain geotechnical information [REDACTED].
- Initial Construction: Barge requirements will be dictated by activities such as the transportation of [REDACTED]
- Maintenance: [REDACTED]

5.1.3

[REDACTED]

[REDACTED]

5.1.4

[REDACTED]

5.1.5

[REDACTED]

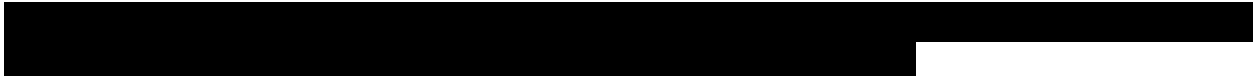
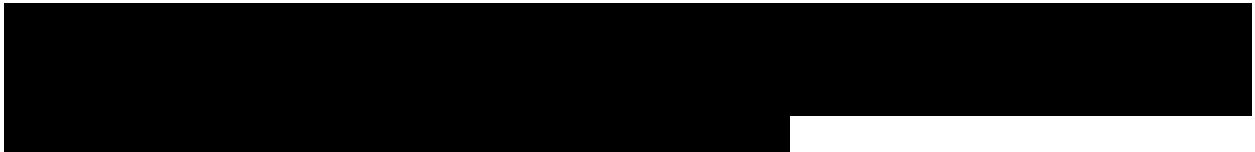
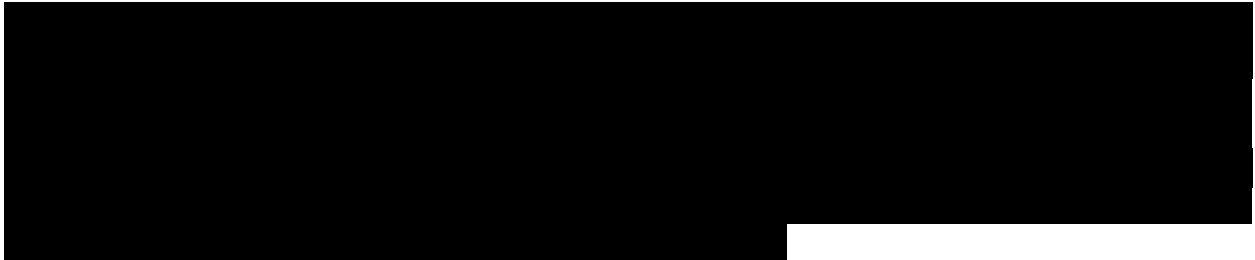
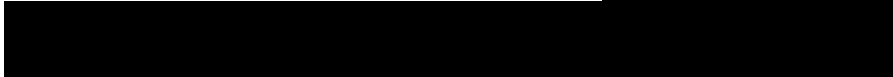
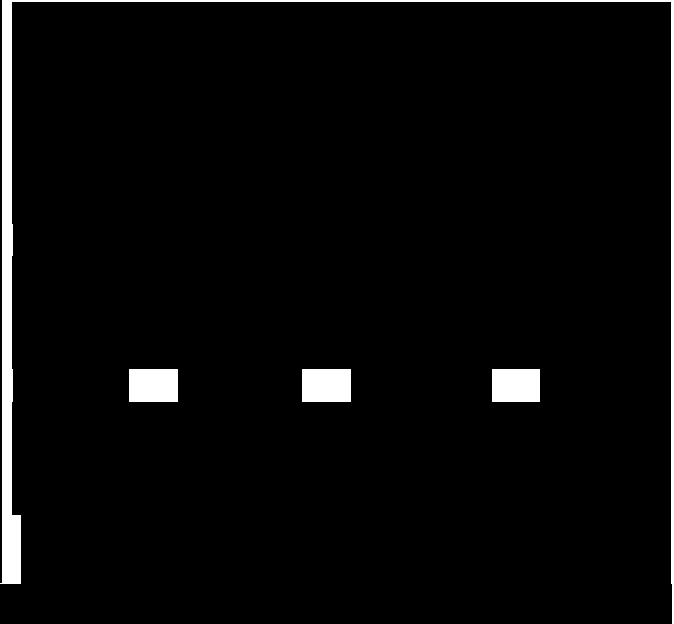
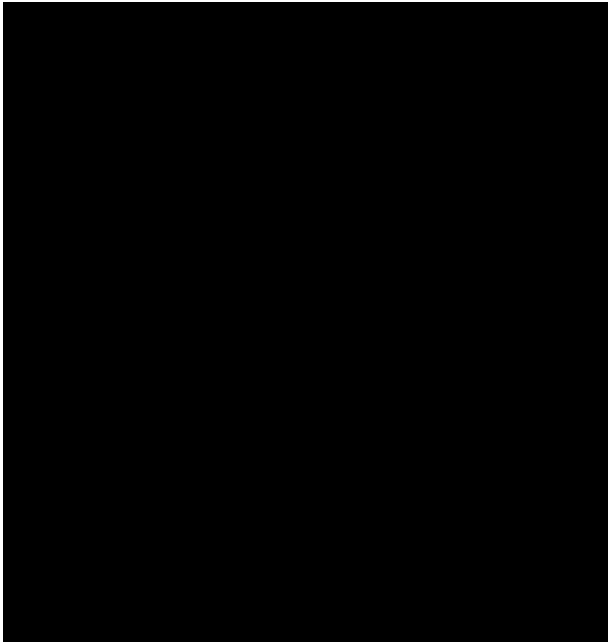
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[REDACTED]

5.1.7

[REDACTED]

5.1.8



5.2 [REDACTED]

[REDACTED]

5.2.1 [REDACTED]

[REDACTED]

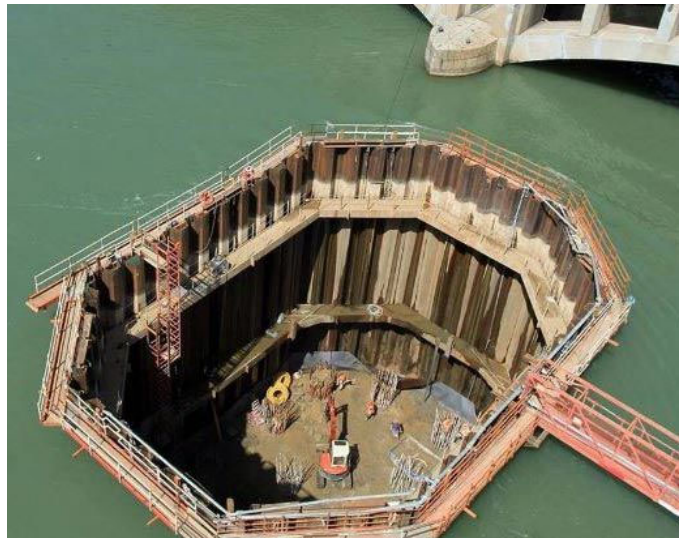


Figure 15. Aerial View of Dewatered Cofferdam (Ref. 7.17)

5.2.2 [REDACTED]

[REDACTED]

5.2.3 [REDACTED]

[REDACTED]

5.2.4 [REDACTED]

[REDACTED]

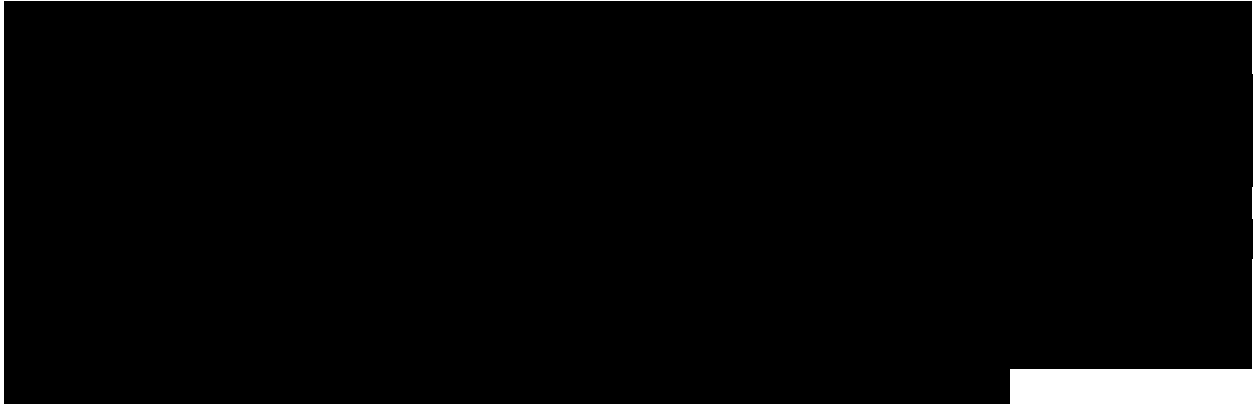
5.3 Other Construction Items

5.3.1 Post installation testing & confirmation of function

The findings of the site-specific study suggested that the automatic air backwash system of the screens would be insufficient to prevent clogging and that the screens would need additional manual cleaning. Therefore, previous estimates of biofouling and clogging rates may be used as a basis but will require updating.

[REDACTED]

Following the construction [REDACTED]
functional testing and system commissioning would be required. [REDACTED]



6.0 Potential Risks

There are several key risks associated with this new configuration.

6.1.1

6.1.2

6.1.3

[REDACTED]

[REDACTED]

6.1.4 [REDACTED]

[REDACTED]

6.1.5 [REDACTED]

[REDACTED]

6.1.6 [REDACTED]

[REDACTED]

6.1.7 [REDACTED]

[REDACTED]

6.1.8 [REDACTED]

[REDACTED]



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- 7.9 International Molybdenum Association (IMOA), “Practical Guidelines for the Fabrication of Duplex Stainless Steels”, 2nd Edition, London UK, 2009.
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- 7.12 Not Used
- 7.13 Survey Report on Water Velocity and Bathymetry Near Schiller Station, Normandeau Associates, Inc., July 2018, Section 3.3
- 7.14 Johnson Surface Water Intake Screens Product Application Guide, Johnson Division, UOP Inc
- 7.15 Gerwick, B.C., and Morris, M.D., “Construction of Marine and Offshore Structures”, 2nd Edition, CRC Press, Boca Raton, 1999.
- 7.16 Evaluation of the Entrainment Reduction Performance of a 3-mm Wedgewire Screen at Merrimack Station, December 2017, Normandeau Associates, Inc.

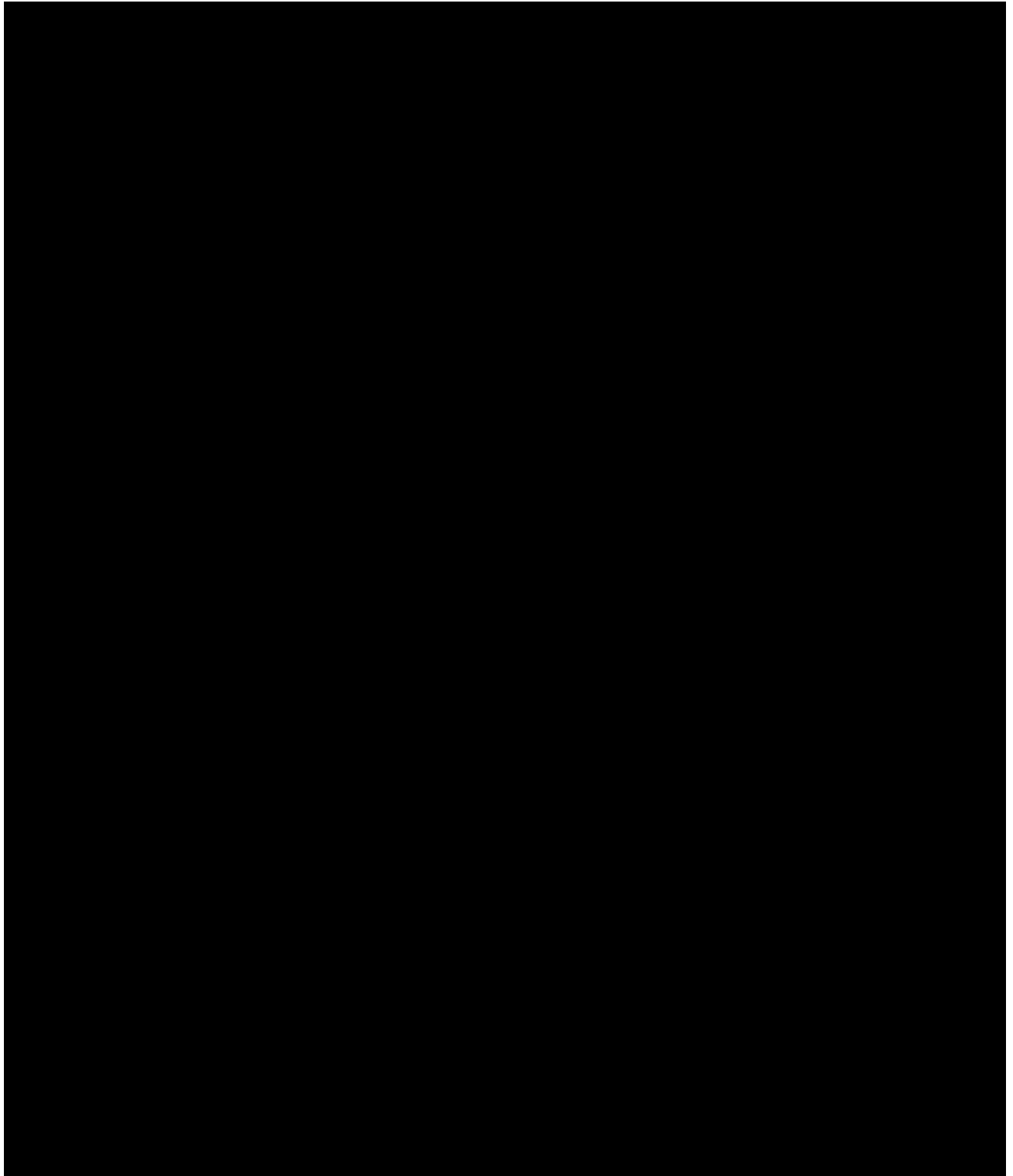
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- 7.17 Image of “Cofferdam Construction project underway, available at:
<https://eddypump.com/education/cofferdam-construction-using-dredge-pumps/>
 - 7.18 Intake Screen Systems, a key element to an advanced water treatment facility, Johnson Screens, available at:
<https://www.aqseptence.com/app/en/keybrands/johnson-screens/>
 - 7.19 Draft Wedgewire Screen Site-Specific Study Scope Description Schiller Station Units 4,5 & 6, Enercon Services & Normandeau Associates, July 2018.
 - 7.20 Permit No. NH0001473, “AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)”

8.0 Attachments

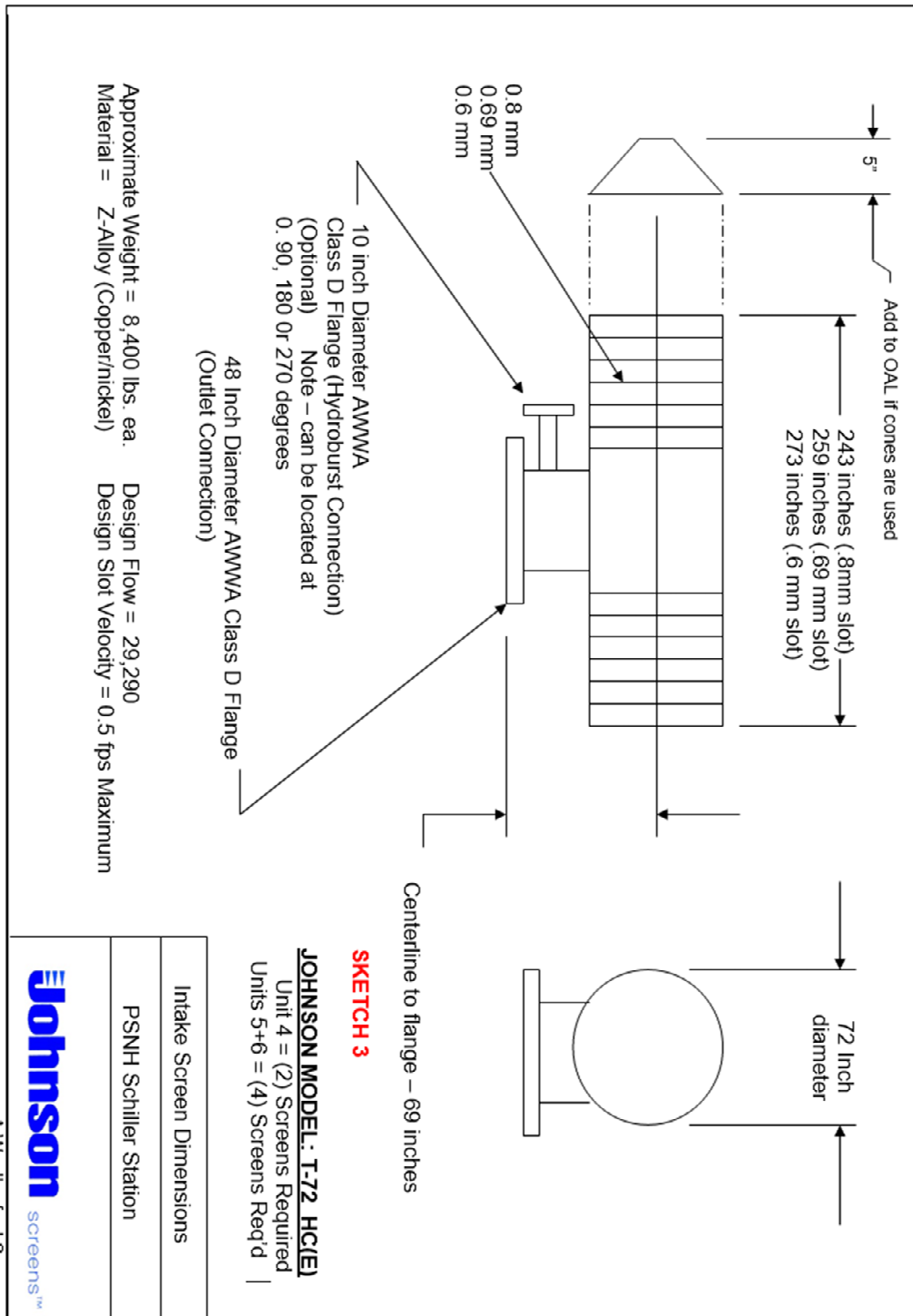
8.1

[REDACTED]

[REDACTED]



8.2 Attachment 2: Johnson Intake Screen Model T-72 HC (E) sketch



8.3

[REDACTED]

[REDACTED]

